A possible case of Garre's sclerosing osteomyelitis from Medieval Tuscany (11th–12th centuries)

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Abstract

Archaeological excavations carried out at the castle of Monte di Croce near Florence brought to light a small cemetery complex belonging to the castle church, dated back to the 11th–12th centuries. An elite stone tomb contained the skeletal remains of a male aged 35–45 years with obvious pathology of the right tibia. The proximal metaphysis and the upper half of the diaphysis appear massively enlarged as a result of severe chronic periostitis. A transverse section illustrates complete obliteration of the medullary cavity by new spongy bone, with some large cavitations. The primary, but completely remodeled tibial shaft is still recognizable. This finding and the strong sclerotic reaction with some central cavitations rule out any form of bone tumor and indicate a chronic inflammatory disease. The morphological and radiological picture and the tibial localization suggest a diagnosis of chronic sclerosing osteomyelitis of Garre, a rare form of chronic osteomyelitis characterized by an intense periosteal reaction with little or no suppuration.

1. Introduction

Reports on sclerosing osteomyelitis of Garre, a chronic form of osteomyelitis characterized by an intense periosteal reaction with little or no suppuration, are absent in the paleopathological literature. To the best of our knowledge, only one paper mentions a tibia from Poland affected by this condition, but the diagnosis is not supported by a detailed description and no differential diagnosis was made (Prejzner and Gladykowska-Rzeczycka, 1997).
This paper presents a possible case of sclerosing osteomyelitis of Garre, observed in the tibia of an individual from the Medieval church cemetery of Monte di Croce, in Tuscany. The purpose of this work is to describe the case in detail and to evaluate the results of the imaging study; differential diagnoses, evaluating other possible conditions that can produce features similar to those seen in the tibia from Monte di Croce, such as some forms of bone tumors, syphilis and Paget's disease, are also discussed.

2. Materials and methods

2.1. Archaeological and historical context

The archaeological site of Monte di Croce is located on a hill near the small town of Pontassieve (Florence) and is occupied by the ruins of a Medieval castle and of a church. The castle of Monte di Croce represented an important stronghold of the power of the Counts Guidi, as it controlled the commercial traffic of northern Tuscany in opposition to the nascent comune of Florence. It is well established that the castle was held by a local aristocratic family, the Galiga, strict allied of the Guidi (Cortese, 2005; Cortese, 2007). The army of Florence besieged Monte di Croce in 1143 and, after various vicissitudes, the castle was destroyed in 1154 (Repetti, 1839).

A little church inside the castle was used as a private chapel. The building can be identified as the Church of Saints Miniato and Romolo, already attested at the end of the 11th century. The religious building (13 m × 6.50 m) is reduced to the foundation levels and consists in a single room with apse. The church was enlarged in the 12th century reaching the dimensions of 21.5 m × 10 m, but the works were never completed to the destruction of the castle (Francovich et al., 2003).

Excavations of the church of Saints Miniato and Romolo, conducted in 2001–2002 by the Department of Archaeology and Art History of the University of Siena, allowed full exploration of the small cemetery complex of the castle, dated back to the 11th–12th centuries (Francovich et al., 2003). The importance of the cemetery of Monte di Croce Castle derives from the fact that it is a private cemetery, probably reserved to the burial of the bailiffs and fideles of the castle's lords; paleonutritional analyses revealed in fact that the alimentation of this human group was based on vegetables and was poor in animal proteins, suggesting that the individuals buried in the cemetery did not belong to the aristocratic elite (Fornaciari et al., 2012). A total of 71 individuals, including 35 subadults and 36 adults, were brought to light. This cemetery area included twelve stone burials coffins and many simple fossa burials (Fornaciari et al., 2003).

A tomb (n. 59), leaning against the south wall and made of square stones worked on the surface, was found among the graves surrounding the church. The position and the unusual elaboration lead to the conclusions that this was an elite tomb. It contained the remains of an articulated adult individual (n. 16), who showed pathology in the right tibia (Fig. 1).

Fig. 1. Tomb 59 with skeleton 16 still in situ: the enlargement of right tibia is evident.

Table 1

Diameters of the right and left tibia

	Right tibia (mm)	Left tibia (mm)
Maximum diameter at midshaft	50	29
Transversal diameter at midshaft	44	23
Maximum diameter at the nutrient foramen	53	32
Transverse diameter at the nutrient foramen	51	25

2.2. Skeletal methods

Sex determination was performed on the basis of the morphologic features of the skull and pelvis (Ferembach et al., 1977–79; Buikstra and Ubelaker, 1994). Age at death was estimated from the examination of pubic symphysis morphology (Brooks and Suchey, 1990), dental wear (Lovejoy, 1985) and sternal rib end modification (Loth and Iscan, 1989). The stature was established by the formulas of Trotter and Gleser (1977).
Paleopathological study included both macroscopic and radiological examination. For conventional X-rays a FCR Velocity by Fujifilm computed radiography equipment was used, with the following parameters: 10–12 mAs with 54–60 keV, DFF 110 cm. Computed Tomography (CT) was carried out with a CT scanner Toshiba Aquilion 16, 100 kVp, 100 mA, rotation time 0.5 s, slice thickness 3 mm, DFOV 49.4 × 35.9 cm.

3. Results

The skeletal remains of individual n.16 belong to an adult male aged 35–45 years. The stature is about 177 cm.
The right tibia appears affected by a severe pathology. The bone is not completely preserved: the medial condyle with the underlying spongy bone and the distal epiphysis are missing. Post-mortem damage removed the cortical portion of the bone that included the medial central diaphysis, involving an area of ca 90 × 40 mm and exposing the underlying spongy bone; in addition, the bone is broken transversally, 25 mm under the nutrient foramen.
The tibia appears to be greatly enlarged in correspondence to the proximal metaphysis and the upper half of the diaphysis(Fig. 2). Diameters at midshaft and at the nutrient foramen of the right tibia are significantly larger than those of the left unaffected tibia (Table 1).
The posterior and lateral surface of the proximal metaphysic appears altered by periostitic reaction consisting in plaques of new bone formation, porosities and bone spicules, irregularly disposed; the medial surface of the proximal metaphysis appears less irregular, with porosities and absence of bone spicules. A transverse section of the bone, due to post-mortem breakage, shows a thickened cortex and total sclerotic obliteration of the medullary cavity by new spongy bone; a sub-cortical large cavitation is present in correspondence of the superior-lateral portion of the bone. The posterior portion of the earlier, normal tibial shaft, completely remodeled, is recognizable (Fig. 3).
Radiological examination showed heterogeneous sclerosis along the proximal to mid diaphysis, with bone expansion; new bone levels are disposed parallel to the diaphysis. The cortical compact bone appears to be locally thickened. The complete obliteration of the medullary cavity with endosteal new bone formation

is confirmed, along with cavitations and osteolytic phenomena. The original diaphysis is reabsorbed but still recognizable. Bone sequestra, including drainage channels (cloacae) are absent (Fig. 4).
The CT sections, at different levels, better defined partial (Fig. 5a and b) and total obliteration (Fig. 5c) of the medullary canal; local circumferential cortical thickening and bone lacunae were present.
The residual original diaphysis, visible as cortical bone surrounded by abundant new spongy bone, is recognizable.

Fig. 2. Posterior view of both tibiae, with enlargement and fusiform shape of the right one

Fig. 4. Radiography of the tibiae; heterogeneous sclerosis along proximal to mid shaft of the right tibia with thickening of bone and immature but benign-appearing periosteal new bone formation

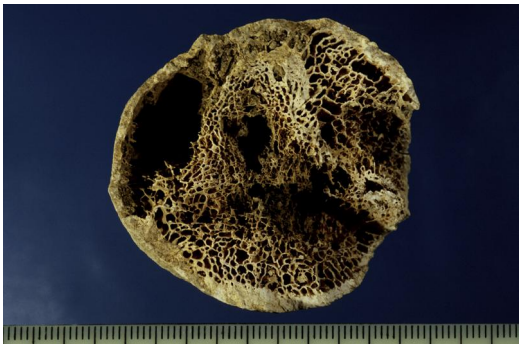


Fig. 3. Section of the right tibia, showing almost complete obliteration of the medullar cavity and residual original diaphysis

No bone lesions or traumatic injuries were observed in the left tibia. The other portions of the cranial and post-cranial skeleton presented no additional evidence of pathology, including trauma.

4. Discussion and conclusions

The macroscopic and radiological features of the left tibia from Monte di Croce (Tomb 59, Skeleton 16) include a fusiform enlargement of the diaphysis caused by strong periosteal reaction, obliteration of the medullary cavity and absence of sequestra and fistulisation. In differential diagnosis several diseases need to be considered, in particular bone tumors, including osteoblastoma, Ewing sarcoma and low grade osteogenic sarcoma, as well as other entities, such as syphilis, Paget's disease and osteomyelitis.

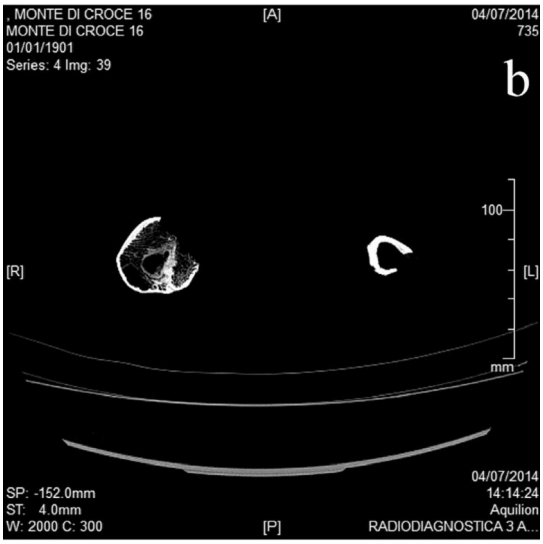
An osteoblastoma is considered a benign tumor, but locally aggressive. The tumor affects males more than females, in a ratio of 2:1, and the age of occurrence is between 10 and 25 years. The most common site of occurrence is the posterior portion of the column, but this tumor can also involve the long bones, in particular the femur and tibia in the medullary cavity and diaphysis, whereas epiphyseal involvement is rare. The tumor contains a central area usually larger than 2 cm and a sclerotic reaction circumscribing the lesion (Atesok et al., 2011). In our case the age is above average, there are internal cavitations, and the involved segment is larger than in osteoblastoma.

Ewing sarcoma is a malignant tumor of bone rarely occurring in patients older than 30 years. The tumor can arise in any bone and the femur and tibia are the most commonly affected long bones (Dorfman and Cerniak, 1998). Ewing sarcoma is highly aggressive, and it causes extensive destruction of the cancellous and cortical bone. Radiological examination reveals a permeative lytic lesion with periosteal reaction, frequently of the "onion-skin" type. In our case the age at onset, the absence of extensive destruction and the presence of the original diaphysis do not support the diagnosis of Ewing sarcoma.

Low-grade central osteosarcoma is a rare form of intramedullary osteosarcoma, whose average age of occurrence is 30 years. The most involved bones are the femur and tibia and the lesion originates in the metaphyseal tract, sometimes extending to the diaphysis (Kashima et al., 2013). Radiographically, both lytic and osteoblastic phenomena coexist in the mixed form (Andresen et al., 2004). However, the structure of the sclerotic lesion visible both in compact and spongy bone, combined with preservation of tracts of the original diaphysis, allow the exclusion of this tumor.

As for other entities, bone involvement is common in tertiary syphilis and the most affected bones are the skull and the tibiae. The lesions on the tibiae correspond to a non-gommatous osteomyelitis, including bone enlargement with narrowing of the medullar cavity; there may also be an anterior bowing, as in "saber shin" tibia (Aufderheide and Rodriguez-Martin, 1998). However, in luetic

osteomyelitis the lesions are commonly bilateral (Ortner, 2003); in our case the diagnosis of tertiary syphilis should therefore be ruled out.
Paget's disease of bone is a metabolic skeletal disease, characterized by excessive resorption followed by excessive formation of bone, with abnormal bone remodeling. Involvement is usually polyostotic and asymmetric, and the most affected bones are the pelvis, spine, skull, femur, and tibia. Mixed lytic and sclerotic changes are typical at X-ray examination (Griz et al., 2014). The deformities in the tibia mainly consist in a marked expansion of bone and anterior bowing (Lee et al., 2004). In the tibia from Monte di Croce (Tomb 59, Burial 16), the absence of bowing deformity and atypical sclerotic and lytic lesions ("mosaic" aspect) exclude Paget's disease.
Osteomyelitis is an inflammatory process caused by pyogenic germs, such as staphylococcus, streptococcus and pneumococcus, that can affect all skeletal segments (Resnick and Niwayama, 1989). The infection produces a local ischemia and subsequent necrosis of the bone segment, forming a sequestrum. The periosteum is stimulated to produce new bone in order to enclose the affected portion, forming an involucrum, that can be perforated by cloacae (Aufderheide and Rodriguez-Martin, 1998).
This appears to represent an acute osteomyelitis that persisted in a chronic state. Chronic sclerosing osteomyelitis of Garre is a rare form of chronic osteomyelitis first described by Carl Alois Philipp Garre in 1893; other names are chronic osteomyelitis with proliferative periostitis, chronic sclerosing osteomyelitis, ossifying periostitis or non-suppurative chronic sclerosing osteomyelitis (Moraes et al., 2014). This condition affects young children and adults, predilecting the male sex (Vannet et al., 2014). The mandible is the most commonly affected bone, but the disease can also affect the metaphyseal region of the long bones (Belli et al., 2002); among the long bones, the tibia is the most preferred localization (Vannet et al., 2014).
Clinically, the onset of the condition is characterised by local pain and reaction in the affected bone, whereas the symptomatology may persist for several months and in some cases even for years, with an episodic non-progressive course and low mortality. During the acute phase the symptoms include pain, heat, redness, tumor growth and deformity. The affected bone generally maintains its function, and most patients appear to be healthy during the interval between episodic exacerbations, (Bernard-Bonnin et al., 1987; Moraes et al., 2014). The radiographic changes consist in general sclerosis, which can produce obliteration of the medullary canal, widening of the cortex and possible cystic changes. There is no evidence of abscesses and sequestra (Nikomarov et al., 2013; Vannet et al., 2014).
The etiology of this pathology has not yet been completely clarified. It seems to originate from an infection caused by low-virulent, anaerobic bacteria (Collert and Isacson, 1982), but in most cases no bacterial growth can be cultured; therefore, the chronic process may be maintained by a low-grade persistent infection (Vienne and Exner, 1997).
In conclusion, in clinical studies chronic sclerosing osteomyelitis of Garre presents as a general sclerosis of the involved segment due to the succession of



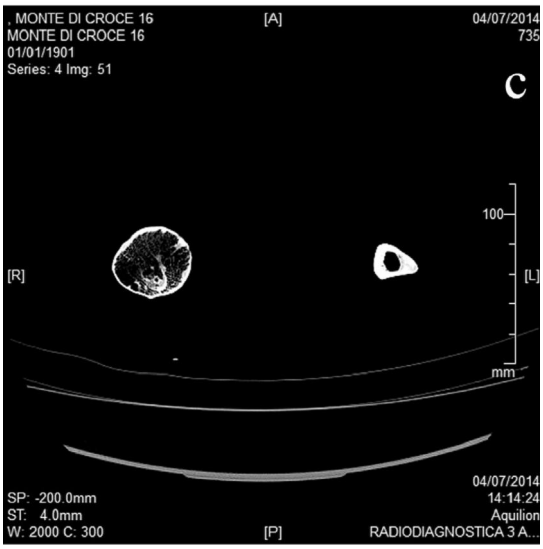


Fig. 5. Cross-sections of the tibiae at CT: narrowing of the medullary canal by sclerotic new bone, circumferential cortical thickening and areas of osteolysis are evident at the level of the metaphysis (a) and superior third of the diaphysis (b); complete obliteration of the medullary canal is visible at the level of midshaft (c); tracts of the original tibial diaphysis are well recognizable in all sections

periosteal reactions to persistent infectious stimuli, with possible areas of osteolysis. Medullary cavities, sequestra and cloacae are typically absent. In dry bone, this condition is described as characterized by regular fusiform shape of the involved portion, absence of medullary cavity, rough surface and absence of sequestrum and fistulisation (Prejzner and Gladykowska-Rzeczycka, 1997). The morphological and radiological features, as well as the tibial localization observed in the case from Monte di Croce (Tomb 59, Burial 16) are most compatible with the clinical and paleopathological features of chronic sclerosing osteomyelitis of Garre, thus making this diagnosis the most probable.

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